

## Original Communication

# Epidemiology of drowning in Mangalore, a coastal Taluk of South India

B. Suresh Kumar Shetty MD (Assistant Professor) \*,  
Mahabalesh Shetty MD (Assistant Professor)

*Department of Forensic Medicine, Kasturba Medical College, Light House Hill Road, Mangalore, Karnataka 575001, India*

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## Abstract

Drowning is a major global public health problem which is amenable to prevention. According to the Global Burden of Diseases 2000 data, the number of deaths caused due to drowning is 449,000 people worldwide (7.4 per 100,000 population). The aim of this study is to derive a profile of drowning victims, to identify the successful drowning preventive measures that may be adopted or enhanced in Mangalore, a coastal Taluk of South India. Retrospective study of deaths caused due to drowning in an 11 years period between 1994 and 2005 was done by reviewing the medical records, the findings of which have been described later.

Epidemiologic profiles of populations at risk and the contributing factors are highlighted while public safety measures are recommended.

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**Keywords:** Drowning; Epidemiology; Risk profile; Safety measures; Immersion deaths

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## 1. Introduction

Drowning is a major, but often neglected public health problem. Drowning affects all age groups but certain groups are particularly vulnerable. Most of the deaths caused due to drowning (nearly 97%) occur in developing countries like ours.<sup>1</sup> In USA and Australia, drowning is the single leading cause of injury deaths in children 1–4 years of age.<sup>2</sup> Drowning is the second leading cause of death from unintentional injury, after road traffic accidents.<sup>1</sup> In India, death by drowning is not highlighted by the health authorities as a major area of concern. Water safety organizations and the public and legislature need adequate information about the circumstances of drowning to initiate the preventive action effectively. The lack of reliable statistical data concerning the impact of this specific form of death in our region/country needs to be emphasized and there has not been much research in this area.

This is especially when hindsight often shows that many deaths from drowning are preventable. Data and knowledge about drowning can only help in better understanding of drowning and in turn lead to more effective measures to tackle the problem.

Mangalore is a beautiful Taluk, in the Southwest part of India with more than 9.3 lakhs of inhabitants, is surrounded by the Arabian Sea and river Nethravathi.

This paper aims to study the epidemiology of drowning in Mangalore, a coastal Taluk of India, over 11 years period. The purpose is to analyze and to quantify the magnitude of death from drowning, and to provide epidemiological data so that preventive measures can be undertaken.

## 2. Materials and methods

The data for epidemiological analysis were obtained from medical record department of District Wenlock Government Hospital, Primary Health Centers, Community Health Centers and Crime Statistics of Mangalore Taluk.

\* Corresponding author. Tel.: +91 9886092392; fax: +91 824 2428183.  
E-mail address: [bellisks@rediffmail.com](mailto:bellisks@rediffmail.com) (B. Suresh Kumar Shetty).

District Wenlock Government Hospital caters to more than 90% of all post mortem examinations in Mangalore Taluk.

Retrospective analysis of all deaths caused due to drowning that have been subjected to autopsy was done. Demographic data gathered included age, sex of the victim, site of the drowning and manner of death. Whereas in unknown bodies only the sex and site of drowning were included. Various sites of drowning such as well/pond, beach/sea, river, lake, swimming pool, tank and drain were also recorded.

A total number of 7551 cases were autopsied during the period 1994–2005 of which 984 cases were death caused due to drowning, i.e. 13.03%. These cases of drowning have been included in the present study.

### 3. Results

The results of the epidemiological study are shown in Figs. 1–5 and Tables 1 and 2. Table 1 shows the drowning rates per lakh population and the total number of deaths caused due to drowning. Fig. 1 shows the distribution of deaths caused due to drowning according to sex. Fig. 2 depicts the trend in the death rates due to drowning in Mangalore Taluk during the study period. Table 2 sets out the gender of the drowning victims and the male to female ratio ( $\chi^2 = 18.502, P = 0.0706$ ). The sex ratio is similar in all the years, except in the year 2004 when such variations were statistically insignificant. Fig. 3 shows the age group of drowned victims during the study period. Fig. 4 depicts the location of drowned victims during the study period 1994–2005. Fig. 5 shows the distribution of sex according to different manners of drowning during the study period.

### 4. Discussion

The data collected in the present study revealed several interesting facts about the drowning situation in Mangalore, a coastal Taluk of South India. Mangalore has a drowning rate per lakh population that varied from as low as 6.81 in 2002 to as high as 13.83 in 1994 in the study period of 1994–2005 as shown in Table 1. This is not com-

parable to the drowning related mortality per lakh population of 1–1.3 in the high income or developed countries of Europe and America.<sup>3–5</sup>

Also it is more than the average global drowning mortality rate of 7.4 per 100,000 population derived from a study of data from “The 2000 Global Burden of Disease Study”, probably the most comprehensive source of global data in drowning.<sup>6</sup>

The study data also show that in 11 years under consideration, the male drowning mortality rate is much higher than the female drowning mortality rate in Mangalore as shown in Fig. 1. There is a general decline in the number of deaths due to drowning during the period 1994–2005 as shown in Fig. 2. In fact, male to female ratio ranged from as low as 2.3:1 in the year 2002 to high 8.7:1 in the year 2004 as shown in Table 2. This correlates with the finding of Tan,<sup>7</sup> i.e. 2.7–11.3. A similar proportion of 4.16 males for every female by Wintemute et al.<sup>8</sup> in USA were observed during the period 1974–1985. In other studies, the following results were observed: 2.31 males for every female in Denmark for the period 1987–1989<sup>9</sup> and 5.3 males for every female in Minnesota for the period 1980–1985.<sup>3</sup>

In the 11-year study, the age group of 21–30 years had the largest number of drowned victims as shown in Fig. 3, while in the previous study of Mangalore City the age group of 31–40 years was revealed to be more vulnerable to drowning.<sup>10</sup> The previous study done in Mangalore city included only urban areas but the present study involves both rural and urban areas. In the present study, drowning of children below the age of 15 years is much lower unlike the western countries where it is generally higher.<sup>11,6</sup> A possible explanation in Mangalore Taluk is that the parents are more careful about their young children. Further research in this area may lead to better understanding of this situation.

The present retrospective study over 11-year period reflected that wells/ponds were the locations with the highest number of drowned victims as shown in Fig. 4, followed by rivers, seas and lakes which are considered to be the next three important locations of drowned victims, respectively. In our study, there was an interesting case of death caused due to drowning in crude oil in an oil container ship. Not a single death caused due to drowning in bathtubs was seen but only one case of drowning in a swimming pool was reported. This is in contrast to developed countries where death caused due to drowning in swimming pool constituted 22–44.5% and in bathtubs 7%, respectively.<sup>12,13</sup> The reason is due to less usage of bathtubs and swimming pools in Mangalore Taluk, which is a developing Taluk in a developing country.

Unfortunately very few countries report cases of drowning to the World Health organization, with an inclusion of the place of injury or related risk factors such as alcohol consumption according to the international classification of diseases. Therefore, a comparison of this factor could not be made globally.<sup>6</sup>

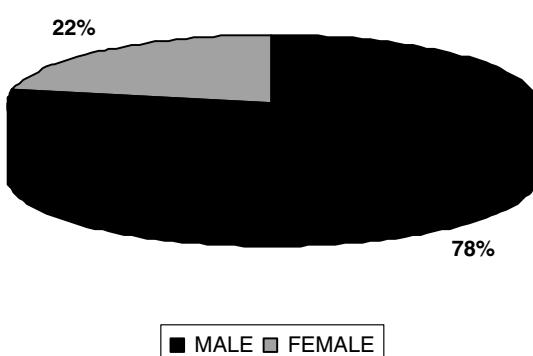


Fig. 1. Distribution of deaths caused due to drowning according to sex.

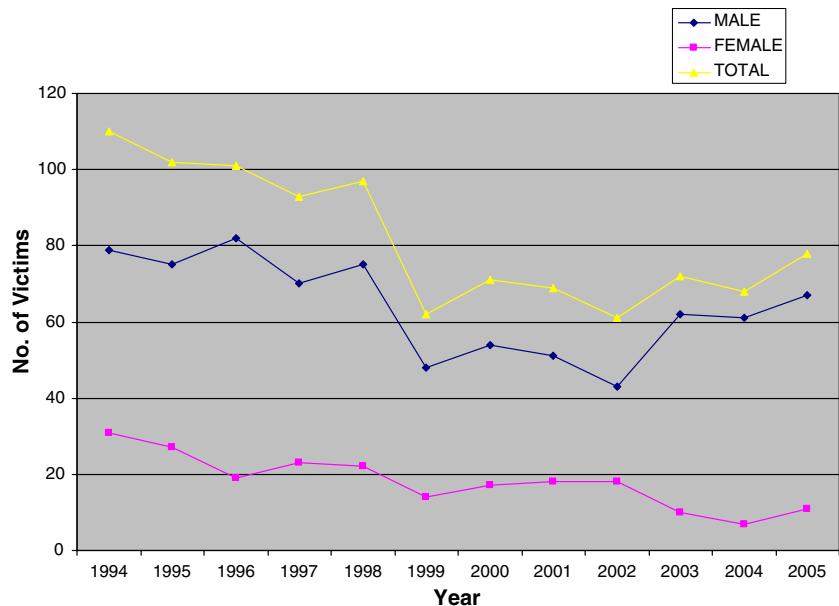


Fig. 2. Trend in the death rate due to drowning in Mangalore Taluk during the period 1994–2005.

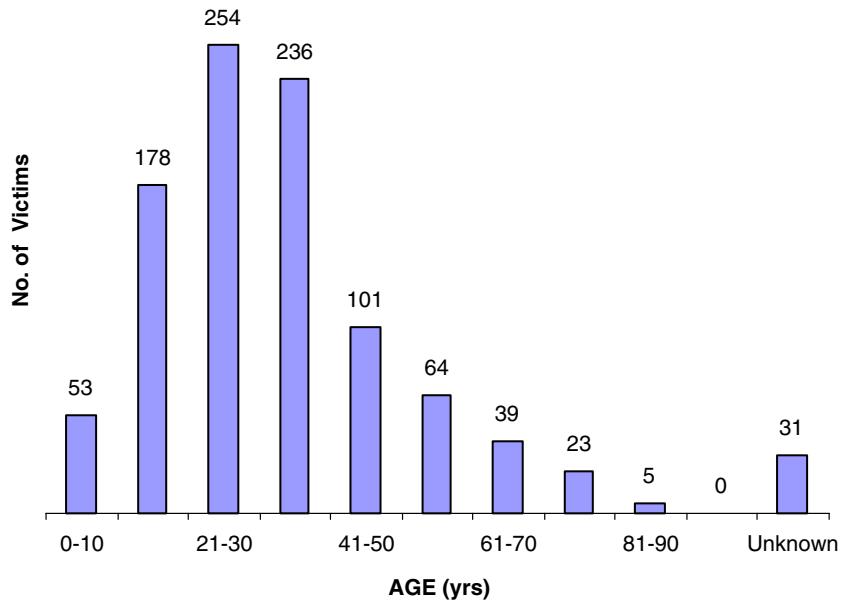


Fig. 3. Graph showing the age groups of drowned victims 1994–2005.

Many authors point out that the increase or decrease in the incidence of this form of death in a year is closely related to seasons, climatic factors and geographic zone where this death occurs.<sup>3–5,14</sup> Our study confirms that the majority of deaths took place during the rainy season, when water levels in the ponds/lakes, rivers, wells are high, in contrast to the west where the majority of deaths took place during the warmer months of the year when water sports are popular.<sup>3–5,14</sup> With regard to the medico legal etiology, three possibilities are traditionally considered: accidental, suicidal and homicidal submersion, although homicidal form of death is of less statistical importance.

Accidental submersion is the most common cause of deaths caused due to drowning as shown in Fig. 5. In this respect, some authors such as Wintemute et al.,<sup>8</sup> Giersten,<sup>15</sup> Derobert<sup>16</sup> and Copeland<sup>17</sup> have reported figures that ranged between 80% and 90% of the total number of deaths caused due to submersion. However, there may be variation depending on the geographic zone where the study is conducted. Our study confirms the fact that 54.06%, i.e. 532 cases of all submersions, were accidental with the male to female proportion key being 4.5:1. This finding defers from those specified by Shepherd,<sup>11</sup> Hedberg et al.,<sup>3</sup> O'Carroll et al.,<sup>13</sup> and Bierens et al.,<sup>18</sup> in their studies.

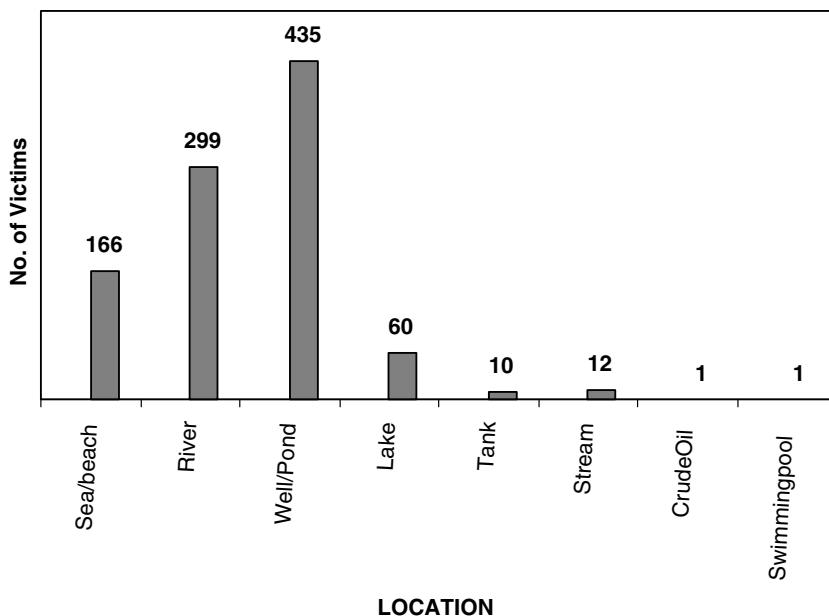


Fig. 4. Graph showing the location of drowned victims during the period 1994–2005.

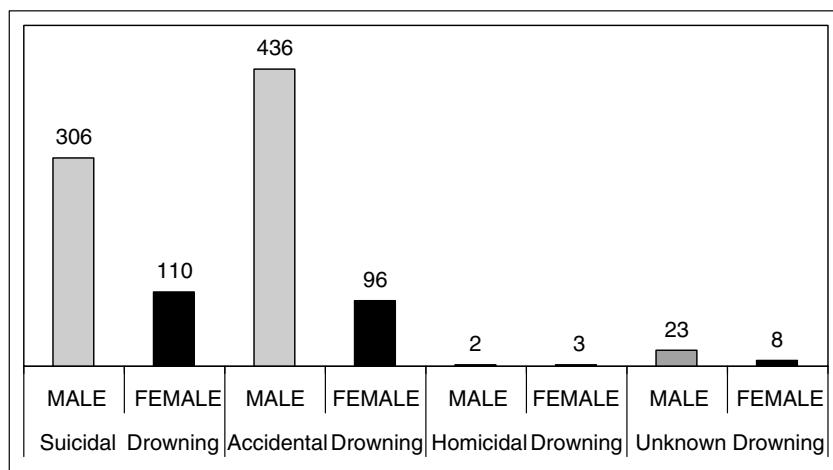


Fig. 5. Graph showing the distribution of sex in different manners of drowned victims during the period 1994–2005.

Table 1  
The statistics of drowned victims of Mangalore Taluk during the period 1994–2004

Year	Population	Total drowning	Rate/lakh
1994	795,012	110	13.83
1995	807,413	102	12.63
1996	819,413	101	12.33
1997	831,619	93	11.18
1998	843,543	97	11.49
1999	855,432	62	7.25
2000	867,101	71	8.18
2001	882,456	69	7.82
2002	894,746	61	6.81
2003	908,563	72	7.92
2004	924,567	68	7.35
2005	934,201	78	8.35

Table 2  
Details of the number of drowned victims based on gender during the period 1994–2005

Year	Male	Female	M:F
1994	79	31	2.5:1
1995	75	27	2.7:1
1996	82	19	4.3:1
1997	70	23	3.04:1
1998	75	22	3.4:1
1999	48	14	3.4:1
2000	54	17	3.1:1
2001	51	18	2.8:1
2002	43	18	2.3:1
2003	62	10	6.2:1
2004	61	7	8.7:1
2005	67	11	6.09:1
Total	767	217	3.5:1

*p* = 0.0706.

On analysis it was found that 42.27% were of suicidal submersion, i.e. 416 cases out of total of 984 cases with 2.7:1 male female ratio. This is much higher than what has been reported by Avis, i.e. 8.9%, and Auer, 18.6%.<sup>19,20</sup> According to the sex of the victim, a clear difference is observed. In the case of females drowning of this nature, a proportion of 26.44% of all suicidal submersions is reached. These percentages are very similar to the 20% obtained by Rodes et al.<sup>21</sup> in the districts of Elda and Villena (Spain) and are significantly lower than the 41.41% and 36.36% obtained by Copeland<sup>17</sup> in Florida and by Avis in Newfoundland,<sup>19</sup> respectively. With regard to males, suicidal submersion reached a proportion of 73.55% of all submersions of this etiology. Similar observations of 80% were obtained in the districts of Elda and Villena,<sup>21</sup> while 58.6% and 63.63% were obtained in Miami<sup>18</sup> and Newfoundland,<sup>19</sup> respectively.

On the other hand, it is pointed out that homicidal submersion is quite uncommon, often with the difficulties of this form entailing when the victim is an adult, unless the latter is first destabilized by some means like alcohol or drugs. Only five cases of homicide were found i.e. two male and three female victims, in which the female babies were of the age groups 3 years, 2(1/2) years and 1 month, respectively. Male babies were of 2 months and 6 months, respectively, here the mothers of the children threw the babies into the well following which they committed suicide. Typically this kind of death is of dyadic nature. These cases represented 0.54% of all deaths caused due to submersion, a smaller percentage compared with the 1% and 2.3% obtained by Wintemute et al.<sup>8</sup> and Copeland<sup>22</sup> in the countries of Sacramento and Florida, respectively.

Bodies whose identity and manner of death could not be established are considered as unknown (undetermined) bodies, which constituted mere 3.4%, i.e. 31 cases of total deaths caused due to drowning in our studies. However, only the location and sex was considered for statistical purpose.

Furthermore, the age groups of undetermined bodies were not known and therefore, the age related conclusions in this situation may differ from the actual situation.

## 5. Conclusion

The present study shows that while the drowning rates in Mangalore are generally comparable to those of low income or developing countries worldwide, the males in Mangalore Taluk are far more at risk of death by drowning than the females. It further shows that the age group of 21–30 years is at more risk of death by drowning and that the most likely locations for drowning incidents are wells/ponds, rivers and seas, respectively.

In the present study, we observed many victims getting drowned in wells/ponds, the reason being most of the wells in these regions are open wells without any fence or barricades. So the safety precautions such as barricading the

well to safeguard the people from getting drowned accidentally have been suggested.

Local data collection or surveillance is needed to identify the specific factors associated with drowning in a particular region, so the main preventive measures may be broadly divided into supervision, environmental design changes, legislation, swimming lessons and aquatic safety education.

Supervision by life guards and providing life saving jackets or devices to those people who venture into seas as well as rivers is a positive indicator in the reduction of drowning or near drowning incidents at beaches or rivers. In addition, there is a need for supervision by parents and other minders.

Swimming skills and water safety measures should be widely taught in the schools and other institutions, which is to be seriously considered by the government. Finally, more studies and research also need to be done to provide a better understanding of the epidemiology of drowning in Mangalore and how deaths by drowning may further be reduced. In the meantime, we hope that the present study has contributed in some way towards the better understanding of this problem.

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